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TITLE: INCLINATION OF PAPER CORRECTING DEVICE

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NAME	COUNTRY
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INT-CL (IPC): B65H009/14

US-CL-CURRENT: 271/227

ABSTRACT:

PURPOSE: To remove jamming on the way of conveying sheets of paper and discrimination error by detecting the inclination of a sheet of paper to the conveying direction and correcting this inclination to be in a proper direction by increasing or reducing each of the conveying speeds of a pair of conveying means.

CONSTITUTION: When a sheet of paper money 51 is conveyed in the direction of the arrow T, light for photosensor alleys SA to SD in which photosensors are arranged in a line at a certain pitch, is shielded. The output signals of the photosensor alleys SA to SD are operated by a control part, to calculate the inclined angle of the paper money 51. And, on a conveying passage for correction consisting of conveying belts 53, 54, the inclination angle of the paper money 51 is removed by relatively hastening or delaying the speeds of the conveying belts 53, 54. A paper money 51' the inclination of which is thus corrected, is conveyed to a pattern detecting device 52. Thereby, jamming in the way of conveying and discrimination error at a paper money discriminating part can be eliminated.

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⑫公開特許公報(A)　昭61－124459

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B 65 H 9/14		7539－3F	

審査請求　未請求　発明の数 1　(全6頁)

⑤4発明の名称　紙葉の傾斜補正装置

②1特　願　昭59－245374

②2出　願　昭59(1984)11月19日

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明　細　書

1.発明の名称

紙葉の傾斜補正装置

2.特許請求の範囲

(1)　1対の搬送手段の上に載せて紙葉を搬送する搬送路において、

紙葉の搬送方向に対する傾きを検知する検知手段と、

前記検知手段で検知した傾きに基づき、紙葉の向きが搬送方向に一致するように、前記1対の搬送手段の各搬送速度を増減する増減手段とを有してなる、紙葉の傾斜補正装置。

3.発明の詳細な説明

(a)技術分野

この発明はＡＴＭ，ＣＤ等の取引処理装置の紙幣搬送部等に適用される紙葉の傾斜補正装置に関する。

(b)発明の概要

本発明に係る傾斜補正装置は、例えばＡＴＭに内臓した紙幣放出機より放出した紙幣が搬送路上で斜めになっているとき、搬送路に設けた搬送ベルトなどの左右の搬送速度を調整することにより、紙幣が搬送方向に正しく向くように紙幣の傾斜を補正するものである。

(c)発明の背景

ＡＴＭ等の取引処理装置においては、搬送ベルト，ローラ等で構成された紙幣搬送装置を使用している。上記構成の紙幣搬送装置では、搬送機械系の誤差，紙幣の腰の強さの影響，紙幣挿入口から紙幣を取り込む際のバラツキ等によって、紙幣が搬送路上で斜めになって搬送される搬送異常をしばしば生じている。しかしながら、紙幣が斜めになると、搬送途中で紙幣のジャムを生じたり、紙幣鑑別部で正常紙幣を異常と判別してしまったりして、紙幣の運用効率およびＡＴＭ等の稼動効率を低下させるといった不都合を生じた。

(d)発明の目的

この発明の目的は上述の点に鑑み、紙幣の搬送方向に対する傾きを検知して正常方向に紙幣の向

きを補正することのできる、紙葉の傾斜補正装置を提供することにある。

(e)発明の構成および効果

この発明は、紙葉の搬送方向に対する傾きを検知する検知手段と、

前記検知手段で検知した傾きに基づき、紙葉の向きが搬送方向に一致するように、前記1対の搬送手段の各搬送速度を増減する増減手段とを有することを特徴とする。

上記構成によりこの発明によれば、紙幣の傾きを検知し、搬送手段の搬送速度を増減することにより紙幣の向きを正常方向に補正することができる。これにより、紙幣が搬送路上で斜めになっても自動的に正常方向に向けて搬送するため、搬送途中での紙幣ジャムや紙幣識別部での識別エラーをなくし、紙幣の運用効率およびＡＴＭ等の稼動効率を向上させることができる。

(f)実施例

第2図はこの発明に係る傾斜補正装置を適用したＡＴＭの紙幣搬送部の平面図、第3図は傾斜補正装置のブロック図、第4図は傾斜角を検知するためのセンサの配置図である。

第4図に示すように、紙幣1は矢印Ｔの搬送方向に搬送される。ＡＣ，ＢＤは搬送方向に直交する方向に間隔ℓ_1をあけて設けた測定線である。ＳＡ，ＳＣは測定線ＡＣに沿って搬送路に配置したホトセンサアレーである。ＳＢ，ＳＤは測定線ＢＤに沿って搬送路に配置したホトセンサアレーである。各ホトセンサアレーはホトセンサを一定のピッチP_1で1列に配列したものである。紙幣は搬送路を通過する際、ホトセンサアレーＳＡ，ＳＢ，ＳＣ，ＳＤを遮光する。ホトセンサアレーによる傾斜角の検知を行った後、第2図に示すように紙幣は一対の搬送ベルト53，54からなる補正用搬送路に導かれる。この補正用搬送路にて紙幣の傾斜が補正された後、紙幣は紙幣のパターン検知装置52に搬送される。51は傾斜した紙幣を、51′は傾斜を補正した後の紙幣を示している。Ｓ11，Ｓ12は補正用搬送路に配置した紙幣搬送検知センサである。

第3図に示すように、制御部はＣＰＵ2，ＲＯＭ3，ＲＡＭ4からなるマイクロコンピュータシステムで構成されている。5はカートリッジ（図示せず）から繰り出した紙幣をパターン検知装置52への搬送路に送り出す紙幣搬送装置である。紙幣搬送装置5および紙幣搬送検知センサＳ11，Ｓ12はインターフェイス（Ｉ／Ｐ）7を介してＣＰＵ2と接続する。ホトセンサアレーＳＡ，ＳＢ，ＳＣ，ＳＤのホトセンサ群の出力はインターフェイス（Ｉ／Ｆ）8を介してＣＰＵ2に与えられる。Ｍ1，Ｍ2は搬送ベルト53，54を駆動するモータである。13，14はモータＭ1，Ｍ2の回転速度、即ち搬送ベルト53，54の搬送速度を設定するための加減算器である。各モータの回転速度を加減算器53，54で設定された速度に調整する制御回路はパルスジェネレータＰＣ1，ＰＣ2と増幅器15，16で構成されている。各搬送ベルトの搬送速度の初期値v_0はインターフェイス（Ｉ／Ｆ）12およびＤ／Ａ変換器9を通じて加減算器13に与えられる。搬送ベルト53の搬送速度に対する補正値v_1はインターフェイス（Ｉ／Ｆ）12およびＤ／Ａ変換器10を通じて加減算器13に与えられる。搬送ベルト54の搬送速度に対する補正値v_2はインターフェイス（Ｉ／Ｆ）12およびＤ／Ａ変換器11を通じて加減算器13に与えられる。

第5図はＲＯＭ3およびＲＡＭ4のメモリエリアを示している。m1は傾斜角の検知および紙幣の傾斜補正を処理するプログラムを記憶するエリアである。m2～m7は傾斜角の検知処理用のエリアである。ℓ_1は前述のように測定線ＡＣ－ＢＤ間の間隔であり、エリアm2に記憶される。ホトセンサの配列ピッチP_1はエリアm3に記憶される。SA_{n1}，SC_{n1}は、紙幣により遮光されたホトセンサアレーＳＡ，ＳＣのホトセンサの数であり、エリアm5に記憶される。SB_{n1}，SD_{n1}は、紙幣により遮光されたホトセンサアレーＳＢ，ＳＤのホトセンサの数であり、エリアm4に記憶される。ℓ_2は第4図に示すように、紙幣1の搬送方向に向いた1辺ＤＥが測定線ＡＣ，ＢＤと

交わった2点A，B間の搬送方向と直交する方向、即ち測定線の方向における位置のズレであり、エリアm6に記憶される。本実施例において検知した紙幣の傾斜角θはエリアm7に記憶される。

m8～m13は傾斜補正処理用のエリアである。ℓ_0は第7図に示すように、平行に配置した搬送ベルト53と54の中心間距離であり、エリアm8に記憶される。ℓ_1は補正用搬送路の中心方向に配置した紙幣搬送センサS11とS12間の距離であり、エリアm9に記憶される。tは紙幣が搬送速度v_0で紙幣搬送センサS11とS12間を移動するのに要する時間であり、エリアm10に記憶される。上記搬送速度の初期値v_0はエリアm11に予め設定される。搬送速度の補正値v_1，v_2はそれぞれエリアm12，m13に記憶される。

次に本実施例における傾斜角検知の動作を第4図および第6図によって説明する。

まずステップn1（以下ステップniを単にniという。），n2にて、紙幣1がホトセンサアレーのところまで搬送されてきたかどうかを判断する。ホトセンサアレーSB，SDのホトセンサ群SB_n，SD_nがそれぞれオンしたときセンサ上に紙幣が到達したと判断する。続いて、検知開始タイミングを得るために、紙幣によって遮光されオンした各ホトセンサアレーのホトセンサの数SA_{n1}，SB_{n1}，SC_{n1}，SD_{n1}より、

$$SA_{n1}+SC_{n1}=SB_{n1}+SD_{n1} \quad \cdots\cdots (1)$$

を満足するかどうかを判断する（n3）。(1)式の関係を満足するときは、第4図に示したように搬送方向に向いた2辺DE，FGが測定線AC，BDに交わっている状態に相当する。

上記(1)式を満足し紙幣が各ホトセンサアレー上に位置していると判断したとき、まずホトセンサ群SA_n，SB_nのオンしているホトセンサの数の差の絶対値、即ち$|SA_{n1}-SB_{n1}|$にピッチP_1を乗算して点A，Bにおける測定線方向の位置ズレℓ_2を算出する（n4）。上記の演算により求めた位置ズレℓ_2はエリアm6にストアする。続いて、（測定線の方向）と（搬送方向）の直交関係から、

$$\theta=\tan^{-1}(\ell_2/\ell_1) \quad \cdots\cdots (2)$$

により傾斜角θを求め、エリアm7にストアする（n5）。

次に前記(2)式で求めた傾斜角θに基づき、紙幣の傾きを補正する。この補正動作を第1図および第7図によって説明する。

紙幣51が第7図に示すように、搬送方向に対し傾斜角θ′傾いているとする。前述の傾斜角検知の終了後、まず搬送ベルト53，54の各搬送速度V1，V2を初期値v_0に設定して各モータM1，M2をオンする（n20，n21）。続いて、エリアm10から紙幣のセンサ間所要時間tを読み出し（n22）、さらに搬送速度の補正値v_1，v_2を0にセットする（n23）。

次にn24にて、紙幣が左右のどちらに傾いているかを判定する。ホトセンサアレーSA，SBのオンしたホトセンサの数SA_{n1}，SB_{n1}を比較して、$SA_{n1}>SB_{n1}$のときは第4図に示すように、矢印Tの搬送方向に対し右上りに傾いている状態と判断する。$SA_{n1}<SB_{n1}$のときは第7図に示すように、矢印Tの搬送方向に対し左上りに傾いている状態と判断する。$SA_{n1}>SB_{n1}$と判断したときは搬送ベルト53を搬送ベルト54の速度より早めるために、D／A変換器10より出力するv_1を正に、D／A変換器11より出力するv_2を負にセットする（n25）。一方、$SA_{n1}<SB_{n1}$と判断したときは搬送ベルト54を搬送ベルト53の速度より早めるために、v_1を負に、v_2を正にセットする（n26）。

D／A変換器10，11の出力の正負をセットし終えた後、紙幣51が紙幣搬送検知センサS11をオンする位置まで搬送されたとき、補正値v_1，v_2を求める（n27～n29）。第7図に示す紙幣51の場合左端部が右端部より先行しているので、紙幣搬送検知センサS11とS12間における紙幣の搬送速度は次のように表される。

まず、搬送ベルト53の搬送速度V1は、

$$V1=(\ell_0+\ell_1\tan\theta')/t \quad \cdots\cdots (3)$$

となる。ここで、$v_0=\ell_0/t$であるので、(3)

式は、

$V1 = v_0 + \ell \cdot \tan\theta' / t$ ……(4)

と表せる。一方、搬送ベルト５４の搬送速度Ｖ２は、

$V2 = (\ell \cdot -\ell \cdot \tan\theta') / t$

$= v_0 - \ell \cdot \tan\theta' / t$ ……(5)

となる。以上の(4)，(5)式より、搬送ベルト５３の搬送速度Ｖ１を$\ell \cdot \tan\theta' / t$（$= v_1$）遅らせ、かつ搬送ベルト５４の搬送速度Ｖ２を$\ell \cdot \tan\theta' / t$（$= v_2$）早めれば、紙幣５１の向きは搬送路を移動する間に正常方向に向く。第７図と逆に右端部が左端部より先行して傾いている場合（第４図参照）は、上記と反対に搬送速度Ｖ１をv_1早め、かつ搬送ベルト５４の搬送速度Ｖ２をv_2遅らせばよい。

傾斜角θ'より搬送速度の補正値v_1，v_2を決めたとき（ｎ２８，ｎ２９）、各補正値をエリアｍ１２，１３にストアするとともにＤ／Ａ変換器１０，１１を通じて加減算器１３，１４にセットする（ｎ３０）。第７図の紙幣５１の場合、搬送ベルト５３の搬送速度Ｖ１を$v_0 - v_1$に、搬送ベルト５４の搬送速度Ｖ２を$v_0 + v_2$にそれぞれ設定する（ｎ３１）。これにより各設定速度になるようにモータの回転速度を調整して左右の搬送ベルトの搬送速度を増減する。この搬送速度の調整によって、紙幣５１は紙幣搬送検知センサＳ１２をオンするところに達したとき、５１′のようにその前端の１辺が搬送方向と垂直になる正常方向に向く（ｎ３２）。紙幣が紙幣搬送検知センサＳ１２まで移動すると、再び搬送速度Ｖ１，Ｖ２の設定値を初期値v_0にしておく（ｎ３３）。勿論、(4)，(5)式から$\theta' = 0$のときは初期値v_0のままでよい。尚、第４図のように、第７図と逆に傾斜している場合には、ｎ３１にて搬送ベルト５３の搬送速度Ｖ１を$v_0 + v_1$に、搬送ベルト５４の搬送速度Ｖ２を$v_0 - v_2$にそれぞれ設定すればよい。

ｎ３１は本発明の増減手段に対応する。

尚、本発明は紙幣以外のレシート等の紙葉にも適用することができる。

4.図面の簡単な説明

第１図はこの発明の実施例である傾斜補正装置の傾斜補正動作を示すフローチャート、第２図は同傾斜補正装置を適用したＡＴＭの紙幣搬送部の平面図、第３図は傾斜補正装置のブロック図、第４図は傾斜角を検知するためのセンサの配置図、第５図は同傾斜補正装置のメモリ構成図、第６図は同傾斜補正装置の傾斜角検知の動作を示すフローチャート、第７図は同傾斜補正装置において搬送速度の補正値を決める方法を説明するための搬送路の平面図である。

１，５１，５１′－紙幣、

５３，５４－搬送ベルト（搬送手段）、

ＳＡ，ＳＢ，ＳＣ，ＳＤ－ホトセンサアレー（傾斜角の検知手段）。

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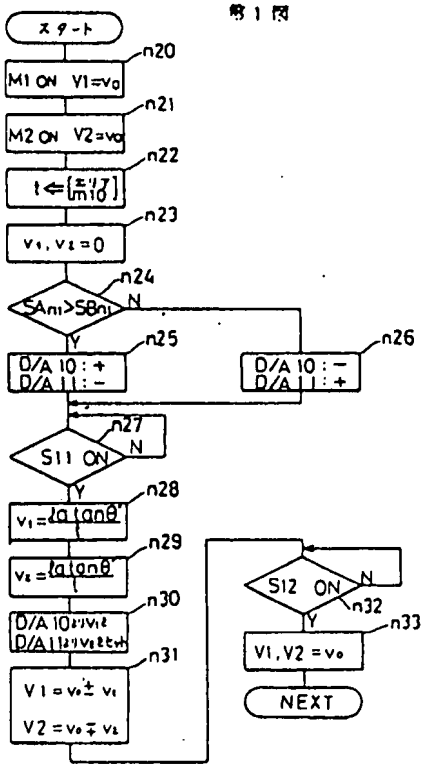
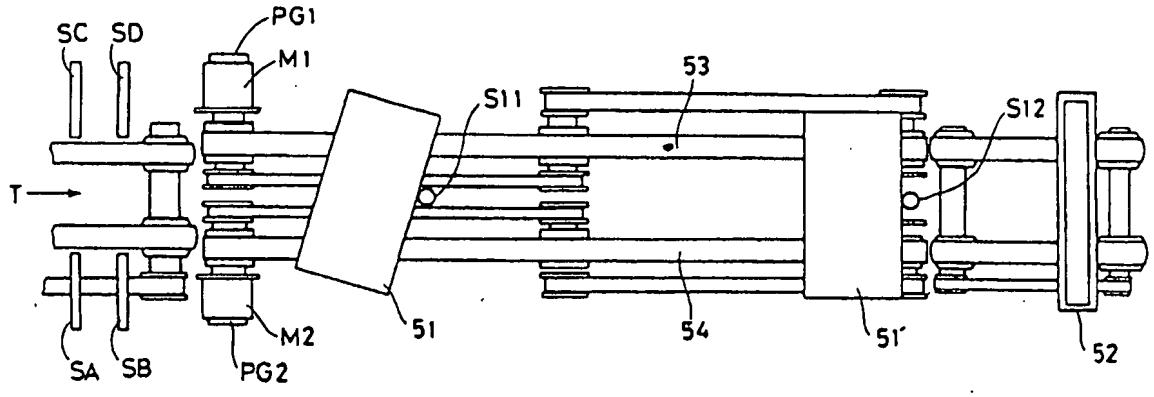
代理人　　弁理士　小森久夫

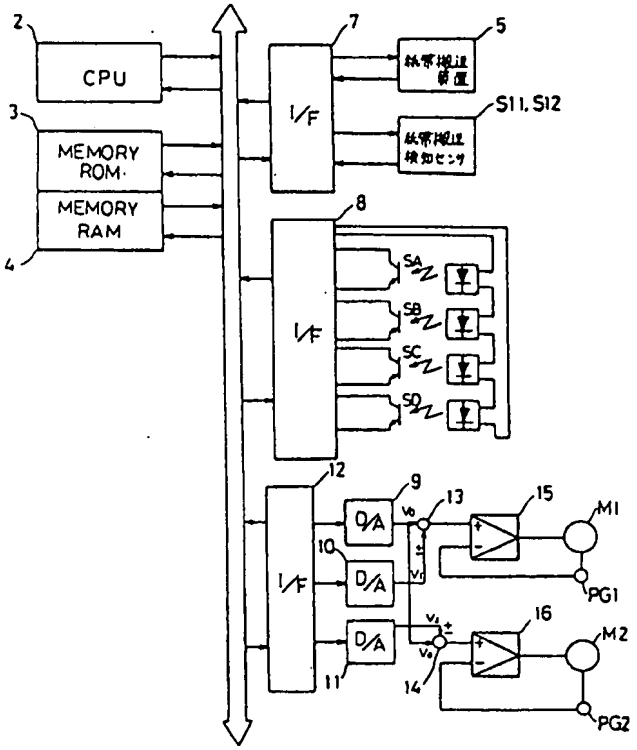
第１図



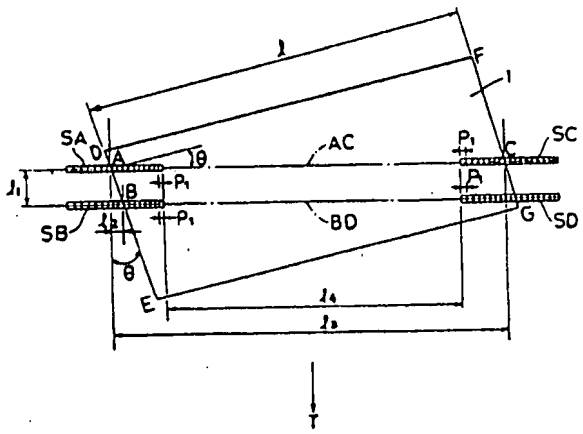
第 2 図


SC
SD
PG1
M1
S11
53
S12
T
SA
SB
PG2
M2
51
54
51'
52

第 3 図


2
CPU
3
MEMORY ROM
MEMORY RAM
4
7
I/F
5
S11, S12
8
I/F
SA
SB
SC
SD
12
I/F
9
D/A
10
D/A
11
D/A
13
14
15
M1
PG1
16
M2
PG2

第 4 図


l
F
1
SA
D
A
θ
AC
P1
C
SC
l1
B
P1
B
SB
l2
P1
BD
G
SD
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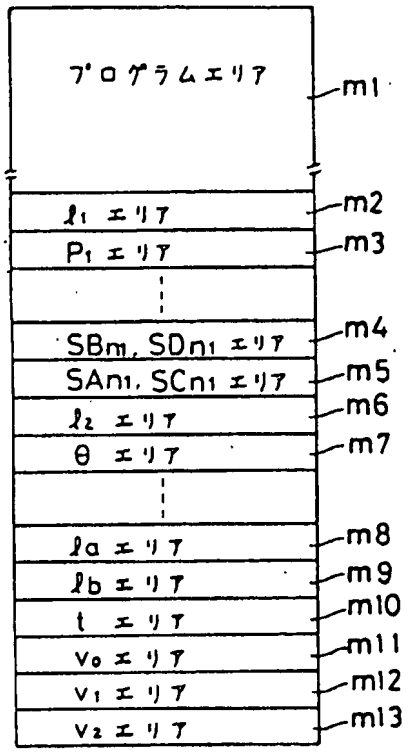
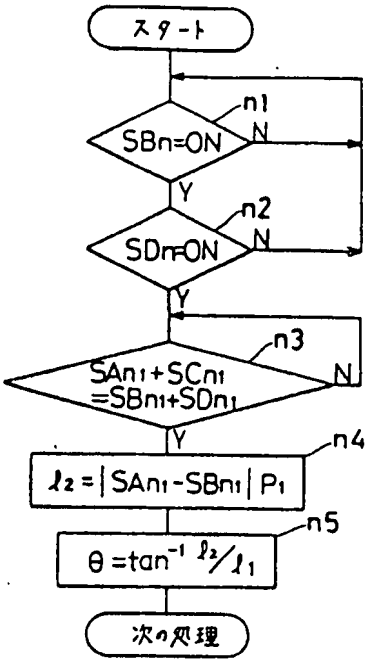
E
l4
l3
T

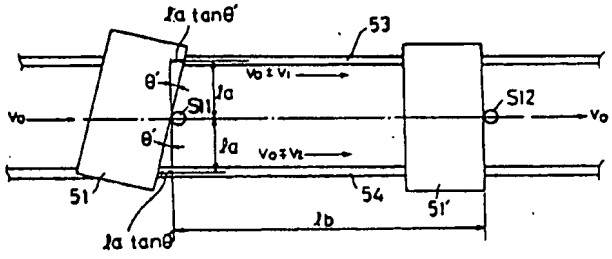
第5図


プログラムエリア
m1
ℓ_1 エリア
m2
P_1 エリア
m3
SBm, SDn1 エリア
m4
SAn1, SCn1 エリア
m5
ℓ_2 エリア
m6
θ エリア
m7
ℓ_a エリア
m8
ℓ_b エリア
m9
t エリア
m10
V_0 エリア
m11
V_1 エリア
m12
V_2 エリア
m13

第6図


スタート
SBn=ON
n1
N
Y
SDn=ON
n2
N
Y
SAn1+SCn1
=SBn1+SDn1
n3
N
Y
$\ell_2 = |SA_{n1} - SB_{n1}| P_1$
n4
$\theta = \tan^{-1} \ell_2/\ell_1$
n5
次の処理

第7図


$\ell_a \tan\theta'$
53
$V_0 \geq V_1$
θ'
ℓ_a
S11
S12
V_0
V_0
θ'
ℓ_a
$V_0 \geq V_2$
51
54
51'
ℓ_b
$\ell_a \tan\theta'$

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PAPER-INCLINATION CORRECTING DEVICE
[Shiyo no keisha hosei sochi]

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UNITED STATES PATENT AND TRADEMARK OFFICE
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Translator's note: "sheet(s) of paper" is used for translating "紙葉 (shiyo)" according to the term used in the original translation summary, although "pieces of paper" may be more suitable.

Specification /383*

1. Name of this Invention

Paper-inclination Correcting Device

2. Claim(s)

[1] Paper-inclination correcting device having a conveying passage for conveying a sheet of paper positioned on a pair of conveying means, wherein said conveying passage comprises (1) a detection means for detecting the inclination of a sheet of paper to the conveying direction and (2) an increasing/reducing means for increasing or reducing each of the conveying speeds of a pair of conveying means based on the inclination detected by said detection means so as to make the direction of a sheet of paper agree with the conveying direction.

3. Detailed Explanation of this Invention

(a) [Technological Field]

This invention pertains to a paper-inclination correcting device applied to a part, such as a bill conveying part of a transaction process device (e.g., ATM, CD, etc.)

(b) [Description of the Prior Art]

The paper-inclination correcting device based on this invention is, for example, used in an ATM, so that when a bill dispensed from a bill dispenser installed in an ATM is positioned aslant on a conveying passage, the inclination of the bill is corrected so as to

* Numbers in the margin indicate pagination in the foreign text.

direct the bill in the correct conveying direction by adjusting the conveying speeds of the right and left conveying belts, etc., provided to the conveying passage.

(c) [Background of this Invention]

A transaction processing device, such as ATM, etc., uses a bill conveying device comprising conveying belts, rollers, etc. With the bill conveying device configured as described above, due to the factors, such as an error caused by a conveying machinery system, effects of bill sturdiness, scattering of bills taken in from a bill insertion inlet, etc., conveying abnormality making a bill conveyed aslant on a conveying passage often occurs. However, when bills are conveyed aslant, problems, such as jamming in the way of conveying and discrimination error discriminating a normal bill as abnormal at a bill discriminating part, occur thereby causing problems, such as reduced operational efficiency in bill transactions and worsened operational efficiency of ATM, etc.

(d) [Purpose of this Invention]

Considering the abovementioned problems, the purpose of this invention is to provide a paper-inclination correction device capable of detecting the inclination of a bill against the conveying direction and correcting the bill direction to a normal direction. /384

(e) [Constitution and Effect of this Invention]

This invention characteristically provides a paper inclination correcting device having a conveying passage, which conveys a sheet

of paper positioned on a pair of conveying means, wherein said conveying passage comprises (1) a detection means for detecting the inclination of a sheet of paper to the conveying direction, and (2) an increasing/reducing means for increasing or reducing each of the conveying speeds of a pair of conveying means based on the inclination detected by said detection means so as to make the direction of a sheet of paper agree with the conveying direction.

With the abovementioned configuration of this invention, a bill positioned aslant can be detected, and the positional direction of the bill can be corrected to the normal direction. Hence, since a bill positioned aslant on the conveying passage can be automatically conveyed in the normal direction, jamming in the way of conveying and discrimination error at a paper money discriminating part can be eliminated. As a result, the application efficiency of bill transaction and the operational efficiency of ATM, etc., can be improved.

(f) [Operational Examples]

Fig. 2 is a front view of the bill conveying part of an ATM to which the inclination correction device based on this invention is applied. Fig. 3 is a diagram of an inclination adjustment device. Fig. 4 is a diagram illustrating the positions of sensors for detecting the inclination angle.

As shown in Fig. 4, a bill is conveyed in the conveying direction indicated by the arrow T. Items AC and BD denote

measurement lines formed in the direction perpendicular to the conveying direction, where AC is positioned away from BD for the distance of ℓ_1. Items SA and SC denote photosensor arrays positioned at the conveying passage along the measuring line AC, whereas items SB and SD denote photosensor arrays positioned at the conveying passage along the measuring line BD. Each photosensor array consists of photosensors arranged in a line at a certain pitch. A bill shields the light for photosensor arrays SA, SB, SC, SD when passing the conveying passage. After the inclination angle is detected by the photosensor arrays, the bill is guided to a conveying passage for correction consisting of a pair of conveying belts 53, 54 as shown in Fig. 2. After the inclination of the bill is corrected by this conveying passage for correction, the bill is conveyed to a bill-pattern detection device 52. Item 51 denotes a bill positioned aslant, and item 51' denotes a bill whose inclined position has been corrected. Items S11 and S12 denote bill conveying detection sensors positioned at the conveying passage for correction.

As shown in Fig. 3, a control section comprises a microcomputer system consisting of a CPU 2, ROM 3, and RAM 4. Item 5 denotes a bill-conveying device which feeds a bill taken out from a cartridge (not shown) to the conveying passage leading to the pattern-detection device 52. The bill conveying device 5 and bill conveying detection sensors S11, S12 are connected to the CPU 2 through an interface (I/F) 7. The outputs of photosensor groups of photosensor arrays SA,

SB, SC, and SD are given to the CPU 2 through an interface (I/F) 8. Items M1 and M2 denote motors for driving conveying belts 53, 54. Each of items 13 and 14 denotes a respective adder-subtracter for setting the rotary speed of applicable motor M1, M2 (i.e., conveying speed of respective conveying belt 53, 54). The control circuit which adjusts the rotary speed of each motor to the speed set by the respective adder-subtracter comprises pulse generators PG1, PG2 and amplifiers 15, 16. The initial value V0 of the conveying speed of each conveying belt is provided to the adder-subtracter 13 through the interface (I/F) 12 and D/A converter 9. The adjustment value V1 to the conveying speed of the conveying belt 53 is provided to the adder-subtracter 13 through the interface (I/F) 12 and D/A converter 10. The adjustment value V2 to the conveying speed of the conveying belt 54 is provided to the adder-subtracter 13 through the interface (I/F) 12 and D/A converter 11.

Fig. 5 is a diagram of memory area for the ROM 3 and RAM 4. In the figure, item m1 denotes the area for storing the program which processes the detection of inclination angle and positional correction of the bill positioned aslant. Items m2 - m7 denote the areas for detecting and processing the inclination angle. Item $\ell 1$, as described above, denotes the space between the measurement lines AC and BD and is stored in the area m2. The arraying pitch P1 of the photosensor is stored in the area m3. Items SAn1 and SCn1 denote the numbers of photosensors of the photosensor arrays SA and SC shielded

from light by the bill and are stored in the area m5. Items SB_{n1} and SD_{n1} denote the numbers of photosensors of the photosensor arrays SB and SD shielded from light by the bill and are stored in the area m4. As shown in Fig. 4, Item $\ell 2$ denotes the positional gap between the conveying direction between two points A, B where one side DE of the bill 1 facing towards the conveyed direction crosses the measurement lines AC and BD, and the direction perpendicular to the conveying direction (i.e., the direction of the measuring lines) and is /385 stored in the area m6. The inclination angle θ of the bill detected in this operational example is stored in the area m7.

Items m8 - m13 denote the areas for inclination correction processing. As shown in Fig. 7, ℓa denotes the distance from the conveying belt 53 or 54 to the center distance point of these conveying belts 53, 54 positioned in parallel with each other and is stored in the area m8. ℓb denotes the distance between the conveyed bill sensors S11 and S12 positioned in the center of the direction of the conveying passage for correction and is stored in the area m9. Item t denotes the time needed for the bill to travel between the bill conveying sensors S11 and S12 at the conveying speed V0 and is stored in the area m10. The initial value V_0 of the abovementioned conveying speed is set in the area m11. The adjustment values v_1, v_2 are stored in the areas m12, m13 respectively.

Next, the following explains the operation of detecting the inclined angle based on this operational example by referring to Figs. 4 and 6.

First, at step n1 (hereafter, step ni is simply called "ni") and n2, the location of a bill 1 is checked so as to determine whether it 1 has been conveyed to the locations of photosensor arrays. In this case, the bill is judged to have arrived at the locations of the sensors when the respective photosensor groups SBn and SDn are turned on. Succeeding to this process, in order to obtain the timing for starting the detection process, the numbers of photosensors SA_{n1}, SB_{n1}, SC_{n1}, and SD_{n1} of each photosensor arrays, having been turned on by being shielded from light by the bill, are applied to the following formula to see if the formula can be satisfied (n3):

$$SA_{n1} + SC_{n1} = SB_{n1} + SD_{n1} \quad \ldots(1)$$

As shown in Fig. 4, the condition providing satisfying formula (1) is equivalent to the case when two sides DE and FG facing towards the conveying direction are crossing the measurement lines AC and BD.

When the abovementioned formula (1) is satisfied to allow the judgment that the bill is positioned on each photosensor array, the absolute value of the difference between the number of turned-on photosensors of the photosensor group SA_n and the number of turned-on photosensors of the photosensor group SB_n (i.e., $|SA_{ni} - SB_{ni}|$) is multiplied by the pitch Pi so as to calculate the positional gap $\ell 2$ between points A and B in the direction of measurement lines (n4).

The positional gap $\ell 2$ acquired by the abovementioned calculation is stored in the area m6. Succeeding to this process, based on the relation (the direction of the measurement line) and (the conveying direction) crossing perpendicularly, the inclination angle θ is obtained using the following formula:

$$\theta = \tan^{-1}(\ell 2/\ell 1) \quad \ldots(2)$$

The result is stored in the area m7 (n5).

Then, the inclination of the bill is corrected according to the inclination angle θ obtained from the abovementioned formula (2). This correction operation is explained below by referring to Figs. 1 and 7.

As shown in Fig. 7, the bill 51 is assumably inclined to the conveyed direction for the inclination angle θ'. After the inclination angle detection process described above, each conveying speeds V_1, V_2 of the conveying belts 53, 54 are first set to the initial value V_0 so as to turn on each motors M1, M2 (n20, n21). Next, the time t needed for the bill to move between the sensors is read out from the area m10 (n22). Moreover, the correction values V1, V2 of the conveying speeds are set to 0 (n23).

Then, at n24, the inclination of the bill is judged to see whether it is to the right or to the left. Subsequently, the numbers of turned-on photosensors SA_{n1} and SB_{n1} of the photosensor arrays SA and SB are compared. If $SA_{n1} > SB_{n1}$, as shown in Fig. 4, it is judged that the bill is inclining towards the upper right to the conveying

direction indicated by the arrow T. On the other hand, when $SA_{n1} < SB_{n1}$, as shown in Fig. 7, it is judged that the bill is inclining towards the upper left to the conveying direction indicated by the arrow T. In the case of judged result of $SA_{n1} > SB_{n1}$, in order to operate the conveying belt 53 faster than the conveying belt 54, the output V_1 from the D/A converter 10 is set to a positive value, while the output V_2 from the D/A converter 11 is set to a negative value (n25). On the other hand, When the judgment result is $SA_{n1} < SB_{n1}$, in order to make the speed of the conveying belt 54 faster than the speed of the conveying belt 53, the output V_1 is set to a negative value while the output V_2 is set to a positive value (n26).

After the completion of setting the outputs of the D/A converters 10, 11 to be a positive value or a negative value respectively, when the bill 51 is conveyed to the position where the conveyed bill detection sensor S11 is turned on, the correction values V_1 and V_2 are acquired (n27 - n29). In the case of the bill 51 shown in Fig. 7, since the left edge of the bill precedes the right edge of the bill, the conveying speed of the bill between the conveyed bill detection sensors S11 and S12 can be expressed as below.

First, the conveying speed V_1 of the conveying belt 53 becomes the following:

$$V1 = (\ell b + \ell a \tan\theta')/t \quad \ldots(3)$$

In this case, since $V_0 = \ell b + t$, the formula (3) can be expressed as the following: /386

$$V1 = V_0 + \ell a \tan\theta'/t \quad \ldots(4)$$

On the other hand, the conveying speed V2 of the conveying belt 54 becomes the following:

$$V2 = (\ell b - \ell a \tan\theta')/t$$

$$= V_0 - \ell a \tan\theta'/t \quad \ldots(5)$$

Based on the formulae (4) and (5), when the conveying speed V1 of the conveying belt 53 is delayed for $\ell a \tan\theta'/t$ ($= V_1$) while the conveying speed V2 of the conveying belt 54 is increased for $\ell a \tan\theta'/t$ ($= V_2$), the direction of the bill 51, while traveling the conveying passage, can be arranged to the normal direction. When the right edge of the bill precedes the left edge of the bill which is the opposite condition of the case shown in Fig. 7 (see Fig. 4), the abovementioned method should be reversed so that the conveying speed V1 is increased for V1 while the conveying speed V2 of the conveying belt 54 is delayed for V2.

When the correction values V1 and V2 of the conveying speeds are determined based on the inclination angle θ' (n28, n29), each correction values are stored to the respective areas m12 and m13, and at the same time, they are set to the adders-subtracters 13, 14 through the D/A converters 10 and 11 (n30). In the case of bill 51 shown in Fig. 7, the conveying speed V1 of the conveying belt 53 is set as $V_0 - V_1$, while the conveying speed V2 of the conveying belt 54

is set as $V_0 + V_2$ respectively (n31). As a result, the rotary speeds of the motors are adjusted to each set speeds in order to increase or decrease the conveying speeds of the right and left conveying belts. With these adjusted conveying speeds, when the bill 51 arrives at the location which turns on the conveyed bill detection sensor S12, as shown with the item 51', the front end side of the bill 51 is directed to position in the normal direction perpendicular to the conveying direction (n32). Once the bill is conveyed to the conveyed bill detection sensor S12, the values set to the conveying speeds V1 and V2 are reset to the initial value V0 (n33). Naturally, if the formulae (4) and (5) produced the result of $\theta' = 0$, the initial value V0 remains the same. Moreover, as shown in Fig. 4, when the bill is inclined in the direction opposite from the inclination shown in Fig. 7, at n31, the conveying speed V1 of the conveying belt 53 is changed to $V_0 + V_1$, while the conveying speed 2 of the conveying belt 54 is changed to $V_0 - V_2$ respectively.

Step n31 corresponds to the addition-reduction means of this invention.

Note that this invention can be applied to sheets of paper such as receipts, in addition to bills.

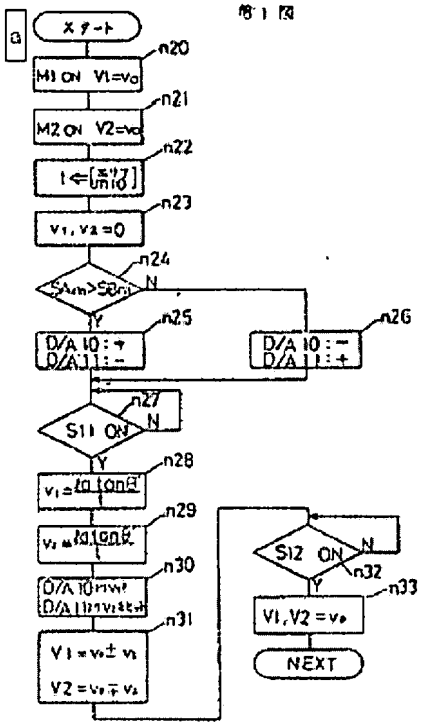
4. Simple Explanation of the Figures

Fig. 1 is a flowchart showing the inclination correction operation of the inclination correction device used in the operational example of this invention. Fig. 2 is a diagram showing

the front view of bill conveying part of an ATM to which the inclination adjustment device shown in Fig. 1 is applied. Fig. 3 is a diagram of an inclination correction device. Fig. 4 is a diagram showing the positions of sensors for detecting the inclination angle. Fig. 5 is a diagram showing the memory configuration of the same inclination correction device. Fig. 6 is a flowchart showing the inclination angle detection operation of the same inclination correction device. Fig. 7 is a diagram showing the front view of the conveying passage for explaining the method of determining the conveying speed correction value by the same inclination correction device.

1, 51, 51'...Bill; 53, 54...Conveying belt (conveying means); SA, SB, SC, SD...Photosensor array (inclination angle detection means)

Figure 1



Key: a) Start;
Step n22) t <- [area m10]; n30) Set V1 from D/A 10, V2 from D/A 11

Figure 2 /387

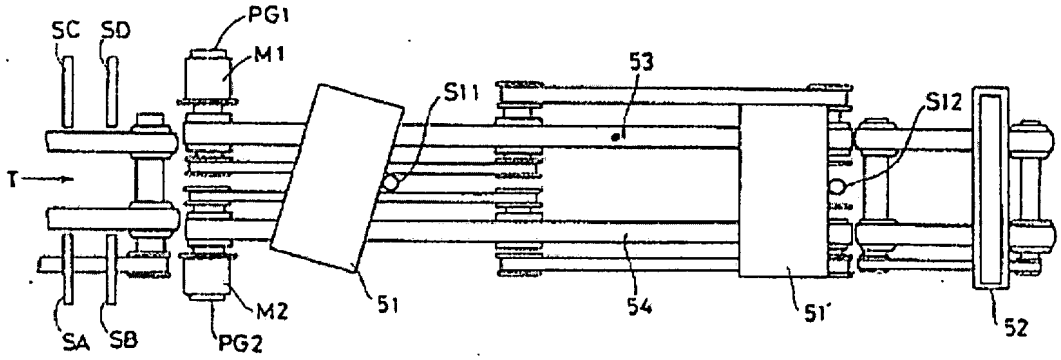
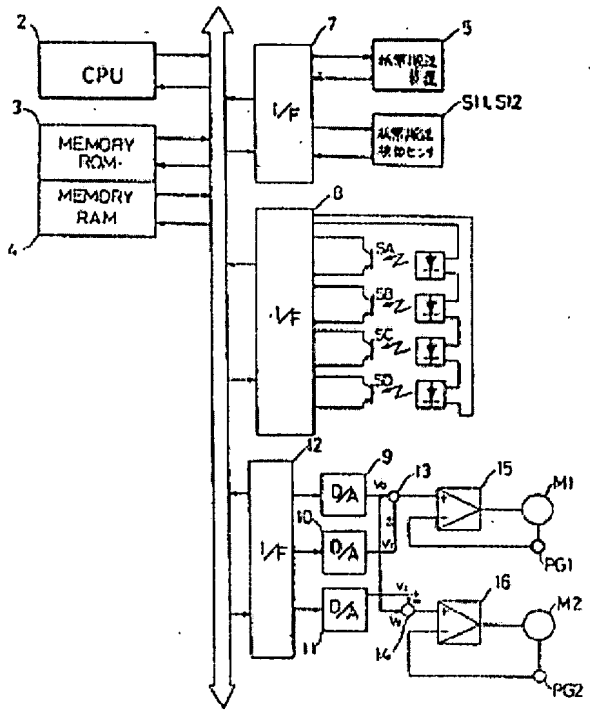


Figure 3



Key 5...Bill conveying device; S11, S12...Conveyed bill detection sensor

Figure 4

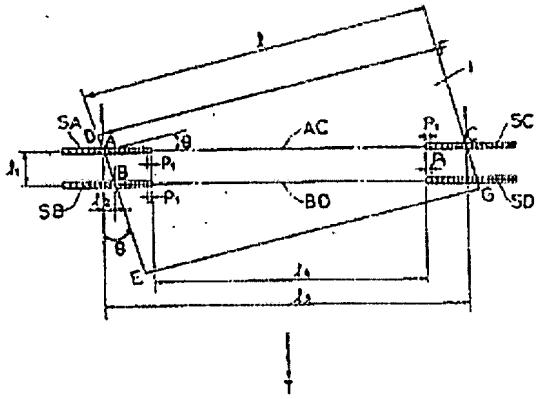
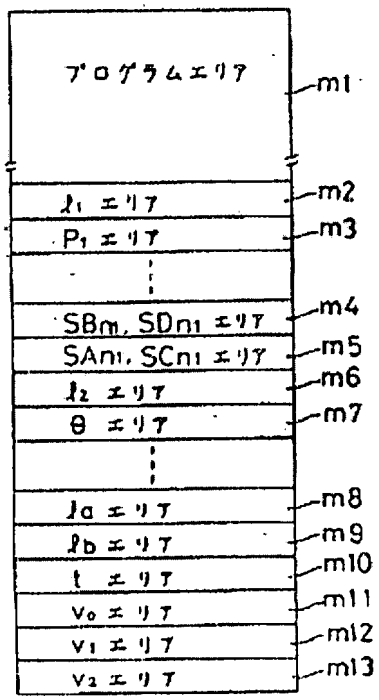
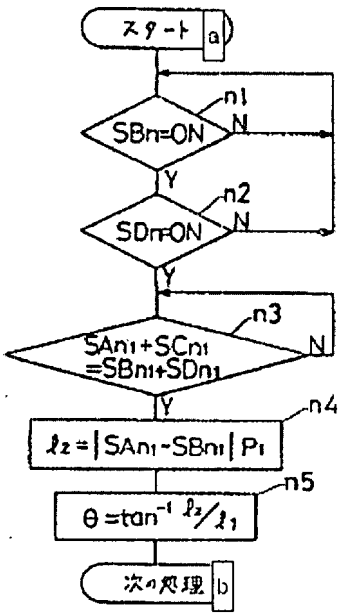


Figure 5



Key: m1...Program area; m2...ℓ1 area; m3...P1 area; m4...SBn1, SDn1 area; m5...SAn1, SCn1 area; m6...ℓ2 area; m7...θ area; m8...ℓa area; m9...ℓb area; m10...t area; m11...V0 area; m12...V1 area; m13...V2 area

Figure 6



Key: a) Start; b) Next process.

Figure 7